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CC: C. A. S. I. Rosa T./207A-3

A. *Title* Participation in the NASA STRAT Mission

B. *Investigator and Institution* Darin W. Toohey, University of California, Irvine

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C. *Abstract* A new instrument to measure CO_2 and H_2O in the lower stratosphere was designed and built to support balloon activities during the STRAT campaign. This instrument was intended to be incorporated into our existing balloon-borne reactive halogen instrument, but was later built as a stand-alone instrument to measure CO_2 after the goals of the STRAT mission were refined. Originally a three-year grant, funding was cancelled at the end of year one when management decided to carry out the campaign with an instrument provided by another group. Year one funding resulted in a fully functional prototype instrument weighing less than 15 kg that can be incorporated relatively easily in existing aircraft and balloon platforms.

D. *Summary of Progress and Results* A new instrument to measure CO_2 and water vapor in the lower stratosphere using the techniques of non-dispersive infrared (NDIR) absorption and photofragmentation fluoresence (PFF) was designed and built at UC Irvine. When coupled to an existing lightweight balloon instrument measuring BrO and ClO, this package was intended to address Objectives 2 and 3 of the STRAT campaign, mainly "To improve understanding of dynamical coupling and rates for transport of trace gases between tropical regions and higher latitudes and lower altitudes," and "To provide data sets for testing two-dimensional and three-dimensional models used in assessments of impacts from stratospheric aviation." To meet these objective, the instrument had to be small and light enough to be incorporated into a larger scientific payload, and it had to employ detection techniques known to produce reliable, high quality data.

The method of vacuum ultraviolet photofragmentation fluorescence was chosen for detection of water vapor based on a long tradition of successful balloon measurements by other groups. For this measurement, the hardware mostly existed with our present resonance fluorescence instrument to measure reactive bromine and chlorine species. Thus, only small optical modifications were required to introduce the capability to measure H_2O, and the main issue to address was that of sampling from a moving balloon platform. Early in the STRAT campaign planning, the Science Team decided against measurements of water vapor on the basis of a high chances for contamination from balloon outgassing, so a final package was never built.

Also early in mission planning it was decided that a standalone instrument would be more desirable, as radical measurements were beyond the scope of the mission. Thus, in year one most of our efforts were focussed on designing and testing a small, lightweight instrument that could be used to detect CO_2 on a multi-payload gondola. We based ours on a fast-response instrument that was flown successfully on the NASA DC-8 and ER-2 aircraft, and that was designed originally by the PI for measurements of CO_2 from aircraft exhaust in plumes. A fast-response Model 6251 Li-Cor NDIR detector is repackaged into an environmentally controlled housing, and ambient air is pressurized to approximately 0.5. Atm with a modified KNF Neuberger diaphragm pump. Differential pressure across the reference and sample cells of the NDIR detector is held fixed to a part-in-10^6 of total pressure by a three-stage pressure control system designed by Prof. Ralph Keeling of UC San Diego for his high-precision atmospheric oxygen measurements.

Instrument response is determined by scanning the differential pressure in the detector over the range of values encountered in the atmosphere, rather than with two dedicated CO_2 standards that must be filled and tested prior to each flight. This procedure results in higher confidence and reproducibility in the response factor, and simultaneously provides for an estimate of spectral contamination from other gases in the sample cell, in particular H_2O. Two dedicated standard gases are carried onboard, one is a commercial mixture of air and CO_2 prepared to match within a few ppm the expected CO_2 abundance, and the second a sample of air intercalibrated against the Scripps (or NOAA) manometric scale that serves to monitor long-term stability of the instrument at the 0.1 ppm level. The commercial mixture serves as the reference gas as well as the sample gas required to determine the zero offset of the instrument.

Use of surface mount technology, PC-104 computer and A/D electronics, and composite hardware resulted in an instrument that weighs less than 15 kg and is sufficiently modular to be incorporated into a variety of platforms. At the present time the instrument is being configured into a multi-instrument package to the tested for long-term monitoring of trace gases with aircraft that fly routinely in the upper-troposphere.

E. *Publications* There are no publications planned at this time.